Single/Dual/Quad 220MHz, 1500V/μs Operational Amplifiers with Programmable Supply Current

FEATURES

- **220MHz Gain-Bandwidth Product**
- **1500V/μs Slew Rate**
- **6.5mA Supply Current per Amplifier**
- **Space Saving MSOP and SSOP Packages**
- **Ultra Small SOT-23 and Leadless DFN Packages**
- **Programmable Current Option**
- 6nV/√Hz Input Noise Voltage
- Unity-Gain Stable
- 1.5mV Maximum Input Offset Voltage
- 8μA Maximum Input Bias Current
- 800nA Maximum Input Offset Current
- 50mA Minimum Output Current, V_{OUT} = ±3V
- ±3.5V Minimum Input CMR, V_S = ±5V
- Specified at ±5V, Single 5V Supplies
- Operating Temperature Range: –40°C to 85°C

APPLICATIONS

- Wideband Amplifiers
- Buffers
- Active Filters
- Video and RF Amplification
- Communication Receivers
- Cable Drivers
- Data Acquisition Systems

DESCRIPTION

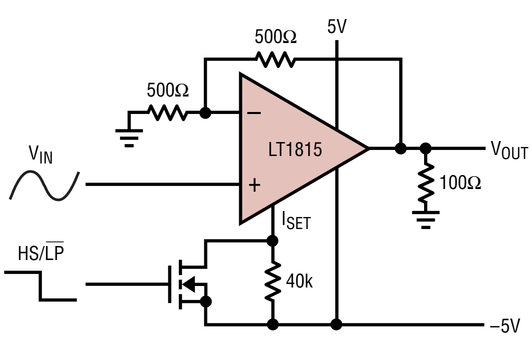
The LT®1815/LT1816/LT1817 are low power, high speed, very high slew rate operational amplifiers with excellent DC performance. The LT1815/LT1816/LT1817 feature higher bandwidth and slew rate, much lower input offset voltage and lower noise and distortion than other devices with comparable supply current. A programmable current option (LT1815 and LT1816A) allows power savings and flexibility by operating at reduced supply current and speed. The circuit topology is a voltage feedback amplifier with the slewing characteristics of a current feedback amplifier.

The output drives a 100Ω load to ±3.8V with ±5V supplies. On a single 5V supply, the output swings from 1V to 4V with a 100Ω load connected to 2.5V. Harmonic distortion is –70dB for a 5MHz, $2V_{P-P}$ output driving a 100Ω load in a gain of –1.

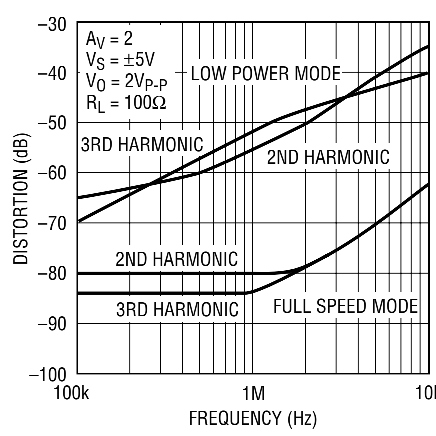
The LT1815/LT1816/LT1817 are manufactured on Linear Technology's advanced low voltage complementary bipolar process and are available in a variety of SOT-23, SO, MSOP, SSOP and leadless DFN packages.

TYPICAL APPLICATION

Programmable Current Amplifier Switches from Low Power Mode to Full Speed Mode



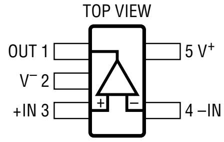
Distortion vs Frequency



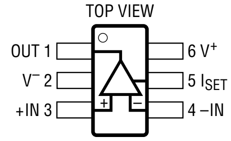
ABSOLUTE MAXIMUM RATINGS (Note 1)

Total Supply Voltage (V^+ to V^-) 12.6V
Differential Input Voltage
(Transient Only, Note 2) .... ±6V
Input Voltage .... $\pm V_S$
Output Short-Circuit Duration (Note 3) .... Indefinite
Operating Temperature Range .... –40°C to 85°C
Specified Temperature Range (Note 8) ... –40°C to 85°C
Maximum Junction Temperature .... 150°C
(DD Package) .... 125°C
Storage Temperature Range .... –65°C to 150°C
(DD Package) .... –65°C to 125°C
Lead Temperature (Soldering, 10 sec) .... 300°C

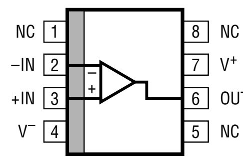
PACKAGE/ORDER INFORMATION



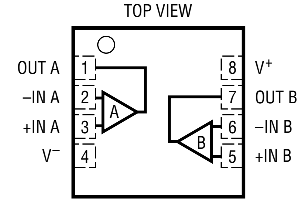
S5 PACKAGE
5-LEAD PLASTIC SOT-23
T_{JMAX} = 150°C, θ_{JA} = 250°C/W (NOTE 9)



S6 PACKAGE
6-LEAD PLASTIC SOT-23
T_{JMAX} = 150°C, θ_{JA} = 230°C/W (NOTE 9)

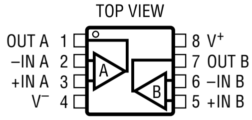


S8 PACKAGE
8-LEAD PLASTIC SO
T_{JMAX} = 150°C, θ_{JA} = 150°C/W (NOTE 9)

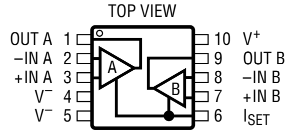


DD PACKAGE
8-LEAD (3mm × 3mm) PLASTIC DFN
T_{JMAX} = 125°C, θ_{JA} = 160°C/W (NOTE 9)
UNDERSIDE METAL INTERNALLY CONNECTED TO V^-

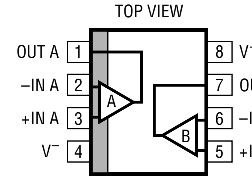
ORDER PART NUMBER	S5 PART MARKING	ORDER PART NUMBER	S6 PART MARKING	ORDER PART NUMBER	S8 PART MARKING	ORDER PART NUMBER	DD PART MARKING*
LT1815CS5 LT1815IS5	LTUP LTVC	LT1815CS6 LT1815IS6	LTUL LTVD	LT1815CS8 LT1815IS8	1815 1815I	LT1816CDD LT1816IDD	LAAR



MS8 PACKAGE
8-LEAD PLASTIC MSOP
T_{JMAX} = 150°C, θ_{JA} = 250°C/W (NOTE 9)

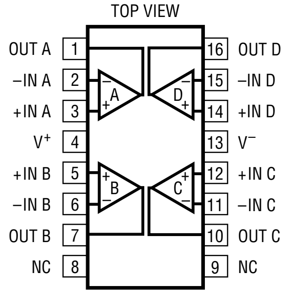


MS10 PACKAGE
10-LEAD PLASTIC MSOP
T_{JMAX} = 150°C, θ_{JA} = 250°C/W (NOTE 9)



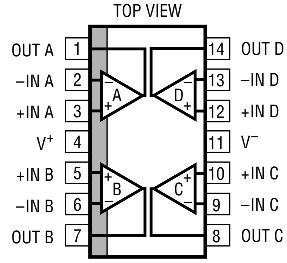
S8 PACKAGE
8-LEAD PLASTIC SO
T_{JMAX} = 150°C, θ_{JA} = 150°C/W (NOTE 9)

ORDER PART NUMBER	MS8 PART MARKING	ORDER PART NUMBER	MS10 PART MARKING	ORDER PART NUMBER	S8 PART MARKING
LT1816CMS8 LT1816IMS8	LTWA LTNQ	LT1816ACMS LT1816AIMS	LTYA LTXX	LT1816CS8 LT1816IS8	1816 1816I



GN PACKAGE
16-LEAD PLASTIC SSOP
T_{JMAX} = 150°C, θ_{JA} = 135°C/W

ORDER PART NUMBER
LT1817CGN LT1817IGN
GN PART MARKING
1817 1817I



S PACKAGE
14-LEAD PLASTIC SO
T_{JMAX} = 150°C, θ_{JA} = 100°C/W

ORDER PART NUMBER
LT1817CS LT1817IS

Consult LTC Marketing for parts specified with wider operating temperature ranges.
*The temperature grades are identified by a label on the shipping container.

ELECTRICAL CHARACTERISTICS

The ● denotes the specifications which apply over the full operating temperature range, otherwise specifications are at T_A = 25°C (Note 8). V_S = ±5V, V_{CM} = 0V unless otherwise noted. For the programmable current option (LT1815S6 or LT1816A), the I_{SET} pin must be connected to V^- through 75Ω or less, unless otherwise noted.

SYMBOL	PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
V_{OS}	Input Offset Voltage	(Note 4) T_A = 0°C to 70°C T_A = –40°C to 85°C	 ● ●		0.2	1.5 2.0 3.0	mV mV mV
	Input Offset Voltage (Low Power Mode) (Note 10)	LT1815S6/LT1816A, 40kΩ Between I_{SET} and V^- T_A = 0°C to 70°C T_A = –40°C to 85°C	 ● ●		2	7 9 10	mV mV mV
$\frac{\Delta V_{OS}}{\Delta T}$	Input Offset Voltage Drift	T_A = 0°C to 70°C (Note 7) T_A = –40°C to 85°C (Note 7)	● ●		10 10	15 30	µV/°C µV/°C
I_{OS}	Input Offset Current	 T_A = 0°C to 70°C T_A = –40°C to 85°C	 ● ●		60	800 1000 1200	nA nA nA
I_B	Input Bias Current	 T_A = 0°C to 70°C T_A = –40°C to 85°C	 ● ●		–2	±8 ±10 ±12	µA µA µA
e_n	Input Noise Voltage Density	f = 10kHz			6		nV/√Hz
i_n	Input Noise Current Density	f = 10kHz			1.3		pA/√Hz
R_{IN}	Input Resistance	V_{CM} = ±3.5V Differential		1.5	5 750		MΩ kΩ
C_{IN}	Input Capacitance				2		pF
V_{CM}	Input Voltage Range	Guaranteed by CMRR T_A = –40°C to 85°C	 ●	±3.5 ±3.5	±4.2		V V
CMRR	Common Mode Rejection Ratio	V_{CM} = ±3.5V T_A = 0°C to 70°C T_A = –40°C to 85°C	 ● ●	75 73 72	85		dB dB dB
	Minimum Supply Voltage	Guaranteed by PSRR T_A = –40°C to 85°C	 ●		±1.25	±2 ±2	V V
PSRR	Power Supply Rejection Ratio	V_S = ±2V to ±5.5V T_A = 0°C to 70°C T_A = –40°C to 85°C	 ● ●	78 76 75	97		dB dB dB
	Channel Separation	V_{OUT} = ±3V, R_L = 100Ω, LT1816/LT1817 T_A = 0°C to 70°C T_A = –40°C to 85°C	 ● ●	82 81 80	100		dB dB dB
A_{VOL}	Large-Signal Voltage Gain	V_{OUT} = ±3V, R_L = 500Ω T_A = 0°C to 70°C T_A = –40°C to 85°C	 ● ●	1.5 1.0 0.8	3		V/mV V/mV V/mV
		V_{OUT} = ±3V, R_L = 100Ω T_A = 0°C to 70°C T_A = –40°C to 85°C	 ● ●	0.7 0.5 0.4	2.5		V/mV V/mV V/mV
V_{OUT}	Maximum Output Swing	R_L = 500Ω, 30mV Overdrive T_A = 0°C to 70°C T_A = –40°C to 85°C	 ● ●	±3.8 ±3.7 ±3.6	±4.1		V V V
		R_L = 100Ω, 30mV Overdrive T_A = 0°C to 70°C T_A = –40°C to 85°C	 ● ●	±3.50 ±3.25 ±3.15	±3.8		V V V

ELECTRICAL CHARACTERISTICS

The ● denotes the specifications which apply over the full operating temperature range, otherwise specifications are at T_A = 25°C (Note 8). V_S = ±5V, V_{CM} = 0V unless otherwise noted. For the programmable current option (LT1815S6 or LT1816A), the I_{SET} pin must be connected to V^- through 75Ω or less, unless otherwise noted.

SYMBOL	PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
I_{OUT}	Maximum Output Current	V_{OUT} = ±3V, 30mV Overdrive		±50	±80		mA
		T_A = 0°C to 70°C	●	±45			mA
		T_A = –40°C to 85°C	●	±40			mA
	Maximum Output Current (Low Power Mode) (Note 10)	LT1815S6/LT1816A; 40kΩ Between I_{SET} and V^-; V_{OUT} = ±3V, 30mV Overdrive		±50	±75		mA
		T_A = 0°C to 70°C	●	±40			mA
		T_A = –40°C to 85°C	●	±30			mA
I_{SC}	Output Short-Circuit Current	V_{OUT} = 0V, 1V Overdrive (Note 3)		±100	±200		mA
		T_A = 0°C to 70°C	●	±90			mA
		T_A = –40°C to 85°C	●	±70			mA
SR	Slew Rate	A_V = –1 (Note 5)		900	1500		V/µs
		T_A = 0°C to 70°C	●	750			V/µs
		T_A = –40°C to 85°C	●	600			V/µs
FPBW	Full-Power Bandwidth	$6V_{P-P}$ (Note 6)			80		MHz
GBW	Gain-Bandwidth Product	f = 200kHz, R_L = 500Ω, LT1815		150	220		MHz
		T_A = 0°C to 70°C	●	140			MHz
		T_A = –40°C to 85°C	●	130			MHz
		f = 200kHz, R_L = 500Ω, LT1816/LT1817		140	220		MHz
		T_A = 0°C to 70°C	●	130			MHz
		T_A = –40°C to 85°C	●	120			MHz
	Gain-Bandwidth Product (Low Power Mode) (Note 10)	LT1815S6/LT1816A; 40kΩ Between I_{SET} and V^-; f = 200kHz, R_L = 500Ω		35	55		MHz
		T_A = 0°C to 70°C	●	30			MHz
		T_A = –40°C to 85°C	●	25			MHz
–3dB BW	–3dB Bandwidth	A_V = 1, R_L = 500Ω			350		MHz
t_r, t_f	Rise Time, Fall Time	A_V = 1, 10% to 90%, 0.1V, R_L = 100Ω			1		ns
t_{PD}	Propagation Delay	A_V = 1, 50% to 50%, 0.1V, R_L = 100Ω			1.4		ns
OS	Overshoot	A_V = 1, 0.1V; R_L = 100Ω			25		%
t_S	Settling Time	A_V = –1, 0.1%, 5V			15		ns
THD	Total Harmonic Distortion	A_V = 2, f = 5MHz, V_{OUT} = $2V_{P-P}$, R_L = 500Ω			–70		dB
dG	Differential Gain	A_V = 2, V_{OUT} = $2V_{P-P}$, R_L = 150Ω			0.08		%
dP	Differential Phase	A_V = 2, V_{OUT} = $2V_{P-P}$, R_L = 150Ω			0.04		Deg
R_{OUT}	Output Resistance	A_V = 1, f = 1MHz			0.20		Ω
I_S	Supply Current	LT1815			6.5	7	mA
		T_A = 0°C to 70°C	●			9	mA
		T_A = –40°C to 85°C	●			10	mA
		LT1816/LT1817, per Amplifier			6.5	7.8	mA
		T_A = 0°C to 70°C	●			10.5	mA
		T_A = –40°C to 85°C	●			11.5	mA
	Supply Current (Low Power Mode) (Note 10)	LT1815S6/LT1816A, 40kΩ Between I_{SET} and V^-, per Amplifier			1	1.5	mA
		T_A = 0°C to 70°C	●			1.8	mA
		T_A = –40°C to 85°C	●			2.0	mA
I_{SET}	I_{SET} Pin Current (Note 10)	LT1815S6/LT1816A		–150	–100		µA
		T_A = 0°C to 70°C	●	–175			µA
		T_A = –40°C to 85°C	●	–200			µA

ELECTRICAL CHARACTERISTICS

The ● denotes the specifications which apply over the full operating temperature range, otherwise specifications are at T_A = 25°C (Note 8). V_S = 5V, 0V; V_{CM} = 2.5V, R_L to 2.5V unless otherwise noted. For the programmable current option (LT1815S6 or LT1816A), the I_{SET} pin must be connected to V^- through 75Ω or less, unless otherwise noted.

SYMBOL	PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
V_{OS}	Input Offset Voltage	(Note 4) T_A = 0°C to 70°C T_A = –40°C to 85°C	 ● ●		0.4	2.0 2.5 3.5	mV mV mV
	Input Offset Voltage (Low Power Mode) (Note 10)	LT1815S6/LT1816A, 40kΩ Between I_{SET} and V^- T_A = 0°C to 70°C T_A = –40°C to 85°C	 ● ●		2	7 9 10	mV mV mV
$\frac{\Delta V_{OS}}{\Delta T}$	Input Offset Voltage Drift	T_A = 0°C to 70°C (Note 7) T_A = –40°C to 85°C (Note 7)	● ●		10 10	15 30	µV/°C µV/°C
I_{OS}	Input Offset Current	 T_A = 0°C to 70°C T_A = –40°C to 85°C	 ● ●		60	800 1000 1200	nA nA nA
I_B	Input Bias Current	 T_A = 0°C to 70°C T_A = –40°C to 85°C	 ● ●		–2.4	±8 ±10 ±12	µA µA µA
e_n	Input Noise Voltage Density	f = 10kHz			6		nV/√Hz
i_n	Input Noise Current Density	f = 10kHz			1.3		pA/√Hz
R_{IN}	Input Resistance	V_{CM} = 1.5V to 3.5V Differential		1.5	5 750		MΩ kΩ
C_{IN}	Input Capacitance				2		pF
V_{CM}	Input Voltage Range (High)	Guaranteed by CMRR T_A = –40°C to 85°C	 ●	3.5 3.5	4.1		V V
	Input Voltage Range (Low)	Guaranteed by CMRR T_A = –40°C to 85°C	 ●		0.9	1.5 1.5	V V
CMRR	Common Mode Rejection Ratio	V_{CM} = 1.5V to 3.5V T_A = 0°C to 70°C T_A = –40°C to 85°C	 ● ●	73 71 70	82		dB dB dB
	Channel Separation	V_{OUT} = 1.5V to 3.5V, R_L = 100Ω, LT1816/LT1817 T_A = 0°C to 70°C T_A = –40°C to 85°C	 ● ●	81 80 79	100		dB dB dB
	Minimum Supply Voltage	Guaranteed by PSRR T_A = –40°C to 85°C	 ●		2.5	4 4	V V
A_{VOL}	Large-Signal Voltage Gain	V_{OUT} = 1.5V to 3.5V, R_L = 500Ω T_A = 0°C to 70°C T_A = –40°C to 85°C	 ● ●	1.0 0.7 0.6	2		V/mV V/mV V/mV
		V_{OUT} = 1.5V to 3.5V, R_L = 100Ω T_A = 0°C to 70°C T_A = –40°C to 85°C	 ● ●	0.7 0.5 0.4	1.5		V/mV V/mV V/mV
V_{OUT}	Maximum Output Swing (High)	R_L = 500Ω, 30mV Overdrive T_A = 0°C to 70°C T_A = –40°C to 85°C	 ● ●	3.9 3.8 3.7	4.2		V V V
		R_L = 100Ω, 30mV Overdrive T_A = 0°C to 70°C T_A = –40°C to 85°C	 ● ●	3.7 3.6 3.5	4		V V V

ELECTRICAL CHARACTERISTICS

The ● denotes the specifications which apply over the full operating temperature range, otherwise specifications are at T_A = 25°C (Note 8). V_S = 5V, 0V; V_{CM} = 2.5V, R_L to 2.5V unless otherwise noted. For the programmable current option (LT1815S6 or LT1816A), the I_{SET} pin must be connected to V^- through 75Ω or less, unless otherwise noted.

SYMBOL	PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
V_{OUT}	Maximum Output Swing (Low)	R_L = 500Ω, 30mV Overdrive T_A = 0°C to 70°C T_A = –40°C to 85°C	 ● ●		0.8	1.1 1.2 1.3	V V V
		R_L = 100Ω, 30mV Overdrive T_A = 0°C to 70°C T_A = –40°C to 85°C	 ● ●		1	1.3 1.4 1.5	V V V
I_{OUT}	Maximum Output Current	V_{OUT} = 1.5V or 3.5V, 30mV Overdrive T_A = 0°C to 70°C T_A = –40°C to 85°C	 ● ●	±30 ±25 ±20	±50		mA mA mA
	Maximum Output Current (Low Power Mode) (Note 10)	LT1815S6/LT1816A; 40kΩ Between I_{SET} and V^-; V_{OUT} = 1.5V or 3.5V, 30mV Overdrive T_A = 0°C to 70°C T_A = –40°C to 85°C	 ● ●	 ±30 ±25 ±20	 ±50		 mA mA mA
I_{SC}	Output Short-Circuit Current	V_{OUT} = 2.5V, 1V Overdrive (Note 3) T_A = 0°C to 70°C T_A = –40°C to 85°C	 ● ●	±80 ±70 ±50	±140		mA mA mA
SR	Slew Rate	A_V = –1 (Note 5) T_A = 0°C to 70°C T_A = –40°C to 85°C	 ● ●	450 375 300	750		V/µs V/µs V/µs
FPBW	Full-Power Bandwidth	$2V_{P-P}$ (Note 6)			120		MHz
GBW	Gain-Bandwidth Product	f = 200kHz, R_L = 500Ω, LT1815 T_A = 0°C to 70°C T_A = –40°C to 85°C	 ● ●	140 130 120	200		MHz MHz MHz
		f = 200kHz, R_L = 500Ω, LT1816/LT1817 T_A = 0°C to 70°C T_A = –40°C to 85°C	 ● ●	130 110 100	200		MHz MHz MHz
	Gain-Bandwidth Product (Low Power Mode) (Note 10)	LT1815S6/LT1816A; 40kΩ Between I_{SET} and V^-; f = 200kHz, R_L = 500Ω T_A = 0°C to 70°C T_A = –40°C to 85°C	 ● ●	 30 25 20	 50		 MHz MHz MHz
–3dB BW	–3dB Bandwidth	A_V = 1, R_L = 500Ω			300		MHz
t_r, t_f	Rise Time, Fall Time	A_V = 1, 10% to 90%, 0.1V, R_L = 100Ω			1.2		ns
t_{PD}	Propagation Delay	A_V = 1, 50% to 50%, 0.1V, R_L = 100Ω			1.5		ns
OS	Overshoot	A_V = 1, 0.1V; R_L = 100Ω			25		%
t_S	Settling Time	A_V = –1, 0.1%, 2V			15		ns
THD	Total Harmonic Distortion	A_V = 2, f = 5MHz, V_{OUT} = $2V_{P-P}$, R_L = 500Ω			–65		dB
dG	Differential Gain	A_V = 2, V_{OUT} = $2V_{P-P}$, R_L = 150Ω			0.08		%
dP	Differential Phase	A_V = 2, V_{OUT} = $2V_{P-P}$, R_L = 150Ω			0.13		Deg
R_{OUT}	Output Resistance	A_V = 1, f = 1MHz			0.24		Ω
I_S	Supply Current	LT1815 T_A = 0°C to 70°C T_A = –40°C to 85°C	 ● ●		6.3	8 10 11	mA mA mA
		LT1816/LT1817, per Amplifier T_A = 0°C to 70°C T_A = –40°C to 85°C	 ● ●		6.3	9 12 13	mA mA mA
	Supply Current (Low Power Mode) (Note 10)	LT1815S6/LT1816A, 40kΩ Between I_{SET} and V^-, per Amplifier T_A = 0°C to 70°C T_A = –40°C to 85°C	 ● ●		 0.9	 1.5 1.8 2.0	 mA mA mA

ELECTRICAL CHARACTERISTICS

The ● denotes the specifications which apply over the full operating temperature range, otherwise specifications are at T_A = 25°C (Note 8). V_S = 5V, 0V; V_{CM} = 2.5V, R_L to 2.5V unless otherwise noted. For the programmable current option (LT1815S6 or LT1816A), the I_{SET} pin must be connected to V^- through 75Ω or less, unless otherwise noted.

SYMBOL	PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
I_{SET}	I_{SET} Pin Current (Note 10)	LT1815S6/LT1816A		−150	−100		µA
		T_A = 0°C to 70°C	●	−175			µA
		T_A = −40°C to 85°C	●	−200			µA

Note 1: Absolute Maximum Ratings are those values beyond which the life of a device may be impaired.

Note 2: Differential inputs of ±6V are appropriate for transient operation only, such as during slewing. Large sustained differential inputs can cause excessive power dissipation and may damage the part.

Note 3: A heat sink may be required to keep the junction temperature below absolute maximum when the output is shorted indefinitely.

Note 4: Input offset voltage is pulse tested and is exclusive of warm-up drift.

Note 5: Slew rate is measured between ±2V at the output with ±3V input for ±5V supplies and $2V_{P-P}$ at the output with a $3V_{P-P}$ input for single 5V supplies.

Note 6: Full-power bandwidth is calculated from the slew rate:

FPBW = SR/2πV_P.

Note 7: This parameter is not 100% tested.

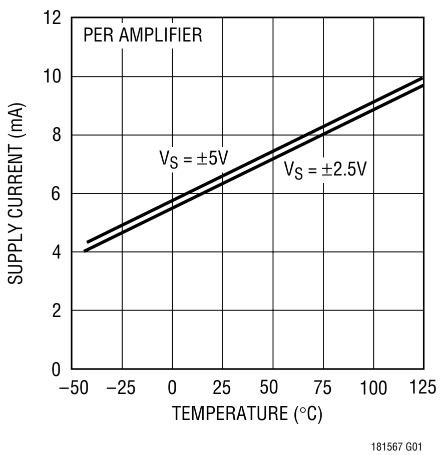
Note 8: The LT1815C/LT1816C/LT1817C are guaranteed to meet specified performance from 0°C to 70°C and are designed, characterized and expected to meet the extended temperature limits, but are not tested at −40°C and 85°C. The LT1815I/LT1816I/LT1817I are guaranteed to meet the extended temperature limits.

Note 9: Thermal resistance (θ_{JA}) varies with the amount of PC board metal connected to the package. The specified values are for short traces connected to the leads. If desired, the thermal resistance can be substantially reduced by connecting Pin 2 of the SOT-23, Pin 4 of the SO-8 and MS8, Pin 5 of the MS10 or the underside metal of the DD package to a large metal area.

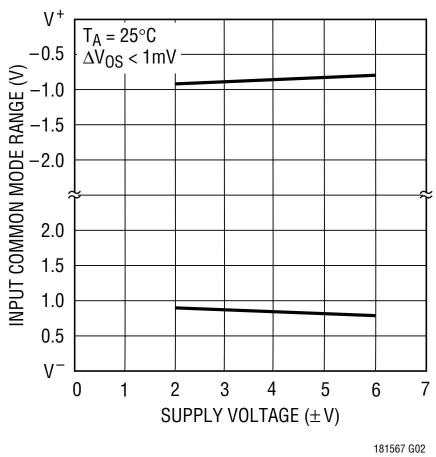
Note 10: A resistor of 40k or less is required between the I_{SET} and V^- pins of the LT1815S6 and the LT1816AMS. See the applications section for information on selecting a suitable resistor.

TYPICAL PERFORMANCE CHARACTERISTICS

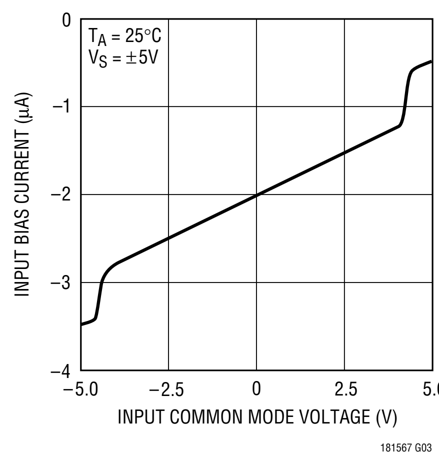
Supply Current vs Temperature



Input Common Mode Range vs Supply Voltage

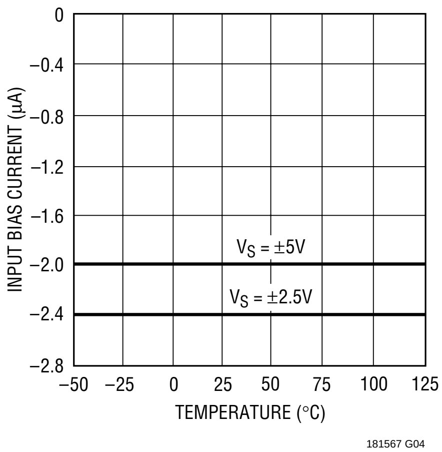


Input Bias Current vs Common Mode Voltage

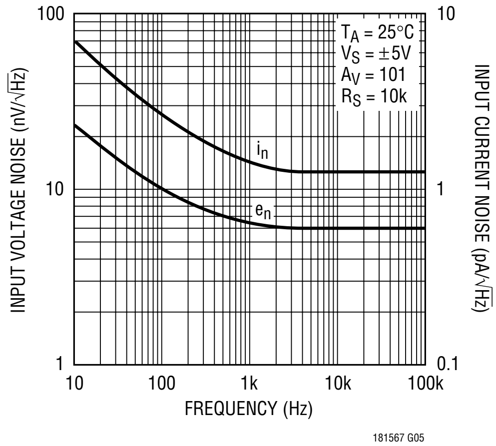


TYPICAL PERFORMANCE CHARACTERISTICS

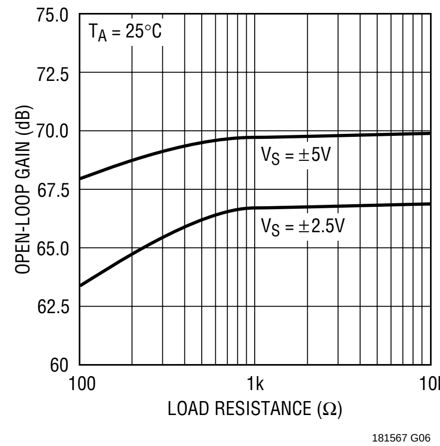
Input Bias Current vs Temperature



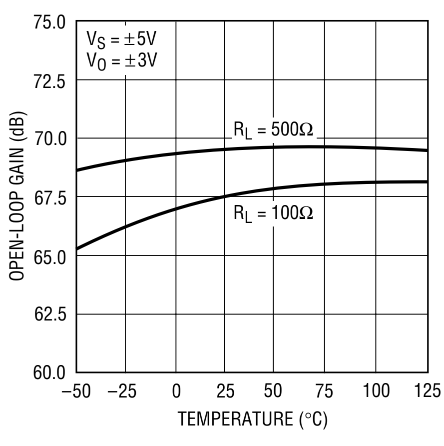
Input Noise Spectral Density



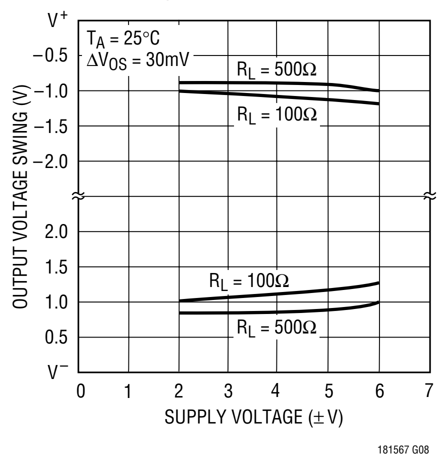
Open-Loop Gain vs Resistive Load



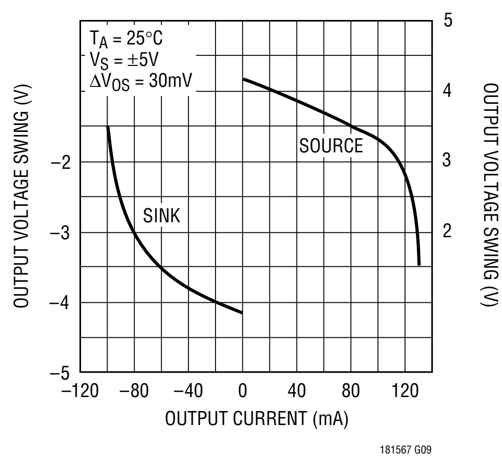
Open-Loop Gain vs Temperature



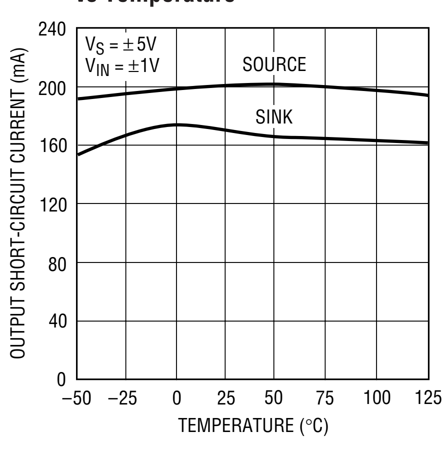
Output Voltage Swing vs Supply Voltage



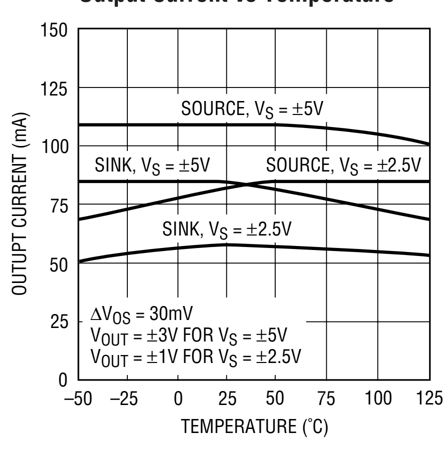
Output Voltage Swing vs Load Current



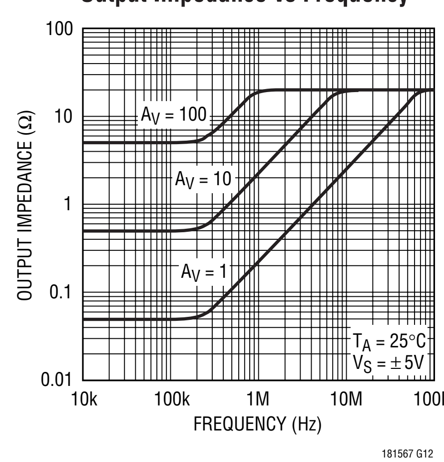
Output Short-Circuit Current vs Temperature



Output Current vs Temperature

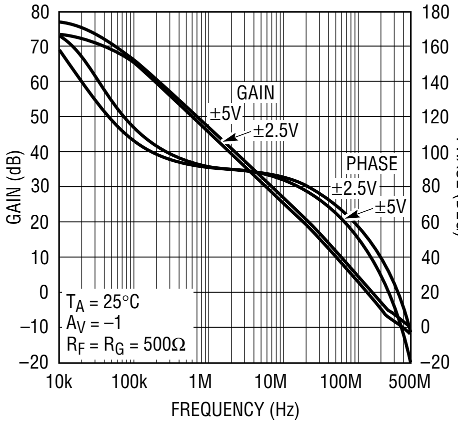


Output Impedance vs Frequency



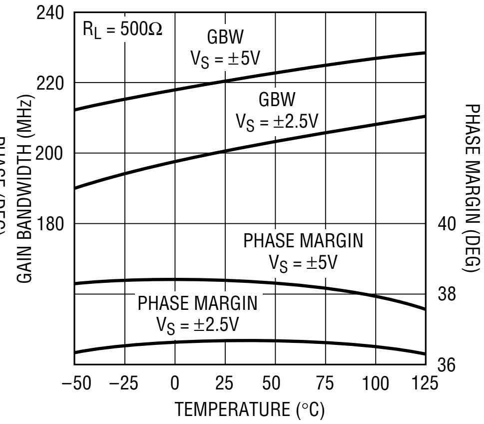
TYPICAL PERFORMANCE CHARACTERISTICS

Gain and Phase vs Frequency



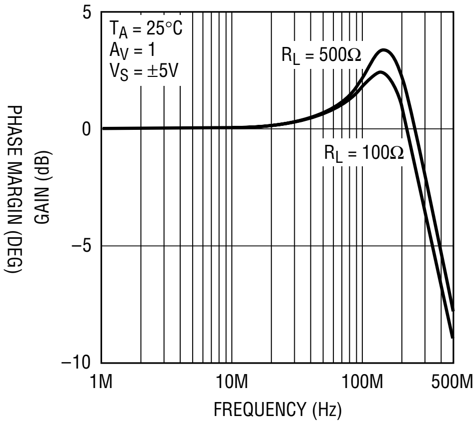
181567 G13

Gain Bandwidth and Phase Margin vs Temperature



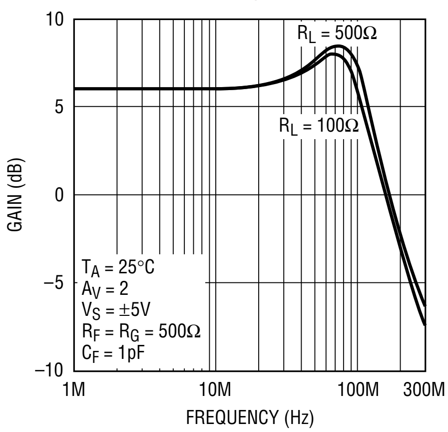
181567 G15

Gain vs Frequency, $A_V = 1$



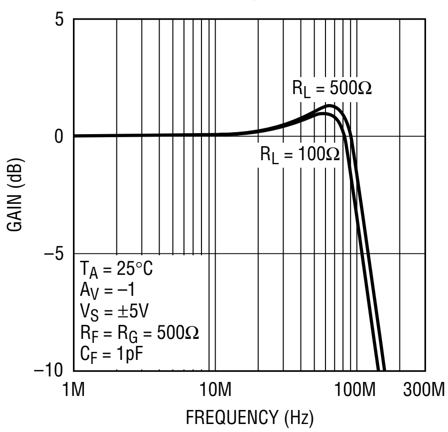
181567 G16

Gain vs Frequency, $A_V = 2$



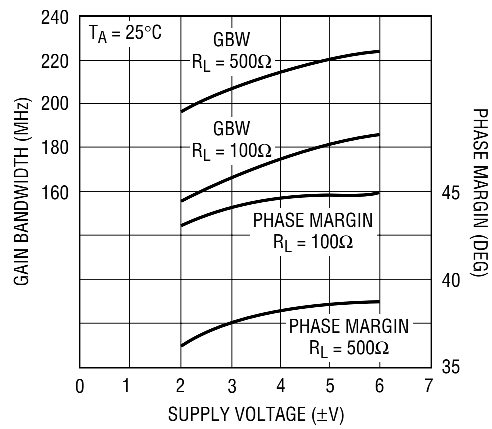
181567 G17

Gain vs Frequency, $A_V = -1$



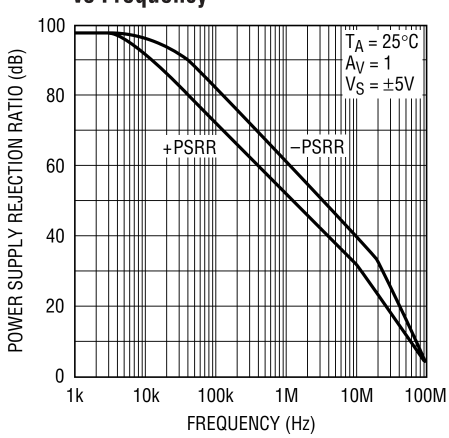
181567 G18

Gain Bandwidth and Phase Margin vs Supply Voltage



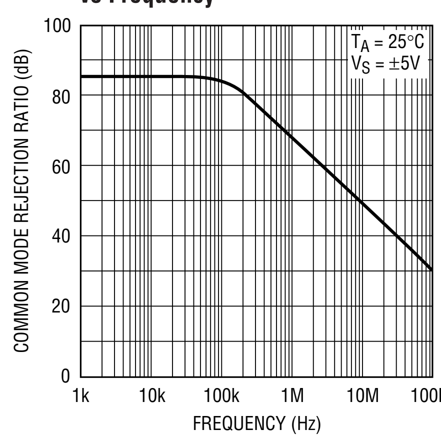
181567 G19

Power Supply Rejection Ratio vs Frequency



181567 G20

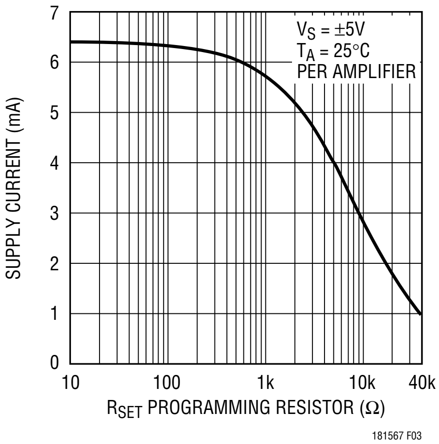
Common Mode Rejection Ratio vs Frequency



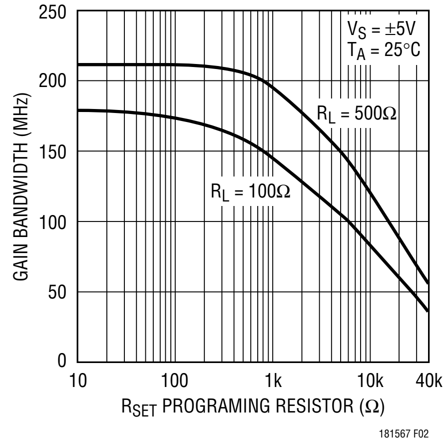
181567 G21

TYPICAL PERFORMANCE CHARACTERISTICS

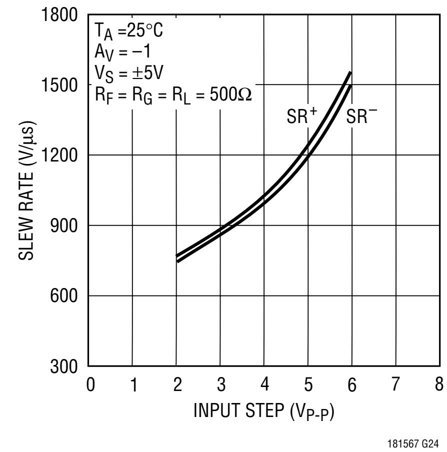
Supply Current vs Programming Resistor



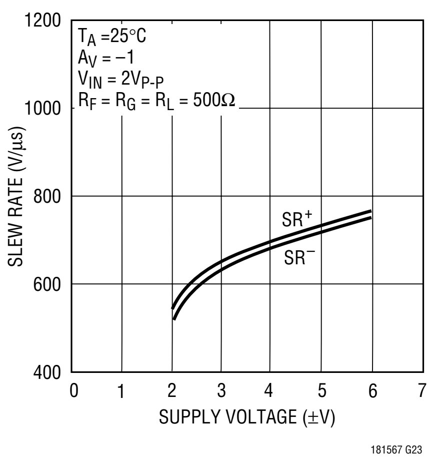
Gain Bandwidth Product vs Programming Resistor



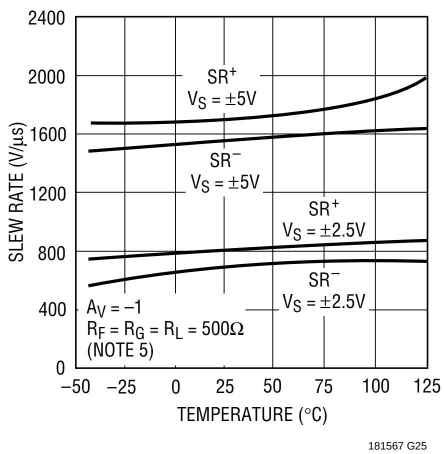
Slew Rate vs Input Step



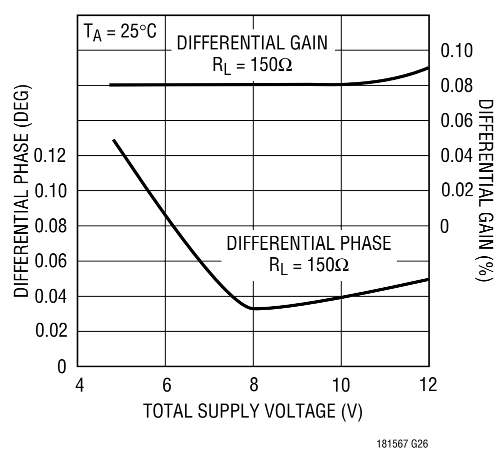
Slew Rate vs Supply Voltage



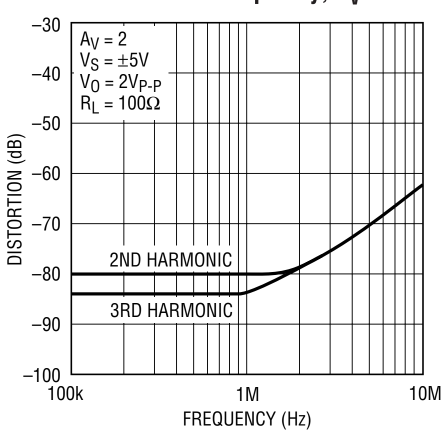
Slew Rate vs Temperature



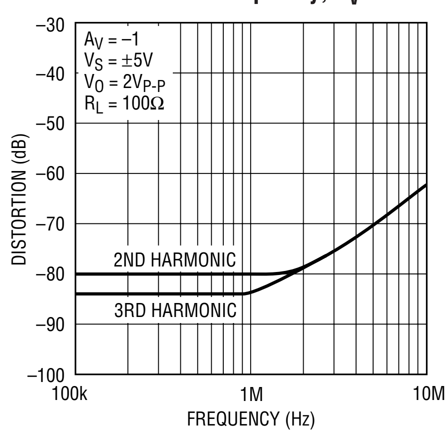
Differential Gain and Phase vs Supply Voltage



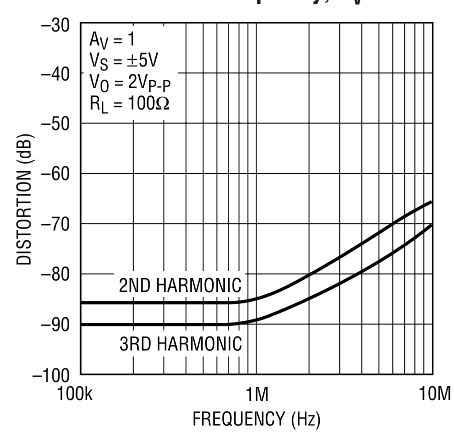
Distortion vs Frequency, $A_V = 2$



Distortion vs Frequency, $A_V = –1$

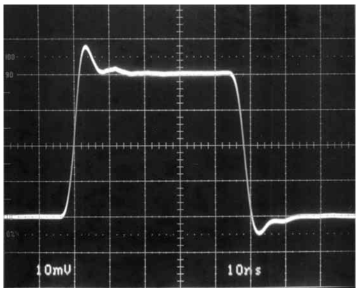


Distortion vs Frequency, $A_V = 1$



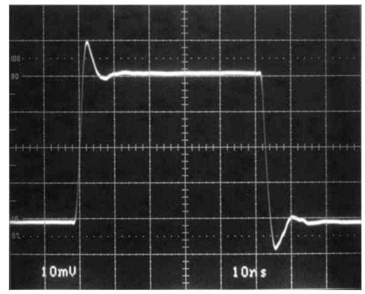
TYPICAL PERFORMANCE CHARACTERISTICS

Small-Signal Transient, $A_V = -1$



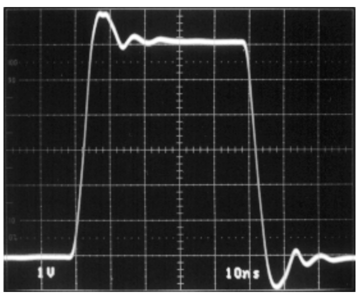
181567 G31

Small-Signal Transient, $A_V = 1$



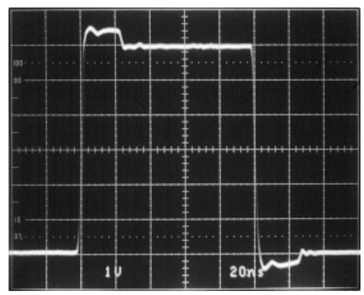
181567 G32

Large-Signal Transient, $A_V = -1$, $V_S = \pm5V$



181567 G33

Large-Signal Transient, $A_V = 1$, $V_S = \pm5V$



181567 G34

APPLICATIONS INFORMATION

Layout and Passive Components

As with all high speed amplifiers, the LT1815/LT1816/LT1817 require some attention to board layout. A ground plane is recommended and trace lengths should be minimized, especially on the negative input lead.

Low ESL/ESR bypass capacitors should be placed directly at the positive and negative supply (0.01μF ceramics are recommended). For high drive current applications, additional 1μF to 10μF tantalums should be added.

The parallel combination of the feedback resistor and gain setting resistor on the inverting input combine with the input capacitance to form a pole that can cause peaking or even oscillations. If feedback resistors greater than 1k are used, a parallel capacitor of value:

$$C_F > R_G \bullet C_{IN}/R_F$$

should be used to cancel the input pole and optimize dynamic performance. For applications where the DC noise gain is 1 and a large feedback resistor is used, C_F should be greater than or equal to C_{IN}. An example would be an I-to-V converter.

Input Considerations

The inputs of the LT1815/LT1816/LT1817 amplifiers are connected to the base of an NPN and PNP bipolar transistor in parallel. The base currents are of opposite polarity and provide first-order bias current cancellation. Due to variation in the matching of NPN and PNP beta, the polarity of the input bias current can be positive or negative. The offset current, however, does not depend on beta matching and is tightly controlled. Therefore, the use of balanced source resistance at each input is recommended for applications where DC accuracy must be maximized. For example, with a 100Ω source resistance at each input, the 800nA maximum offset current results in only 80μV of extra offset, while without balance the 8μA maximum input bias current could result in a 0.8mV offset contribution.

The inputs can withstand differential input voltages of up to 6V without damage and without needing clamping or series resistance for protection. This differential input voltage generates a large internal current (up to 80mA), which results in the high slew rate. In normal transient closed-loop operation, this does not increase power dissipation significantly because of the low duty cycle of the transient inputs. Sustained differential inputs, however, will result in excessive power dissipation and therefore **this device should not be used as a comparator**.

Capacitive Loading

The LT1815/LT1816/LT1817 are optimized for high bandwidth and low distortion applications. They can drive a capacitive load of 10pF in a unity-gain configuration and more with higher gain. When driving a larger capacitive load, a resistor of 10Ω to 50Ω should be connected between the output and the capacitive load to avoid ringing or oscillation. The feedback should still be taken from the output so that the resistor will isolate the capacitive load to ensure stability.

Slew Rate

The slew rate of the LT1815/LT1816/LT1817 is proportional to the differential input voltage. Therefore, highest slew rates are seen in the lowest gain configurations. For example, a 5V output step in a gain of 10 has a 0.5V input step, whereas in unity gain there is a 5V input step. The LT1815/LT1816/LT1817 are tested for a slew rate in a gain of –1. Lower slew rates occur in higher gain configurations.

Programmable Supply Current (LT1815/LT1816A)

In order to operate the LT1815S6 or LT1816A at full speed (and full supply current), connect the I_{SET} pin to the negative supply through a resistance of 75Ω or less.

To adjust or program the supply current and speed of the LT1815S6 or LT1816A, connect an external resistor (R_{SET}) between the I_{SET} pin and the negative supply as shown in Figure 1. The amplifiers are fully functional with $0 \le R_{SET} \le 40k$. Figures 2 and 3 show how the gain bandwidth and supply current vary with the value of the programming resistor R_{SET}. In addition, the Electrical Characteristics section of the data sheet specifies maximum supply current and offset voltage, as well as minimum gain bandwidth and output current at the maximum R_{SET} value of 40k.

APPLICATIONS INFORMATION

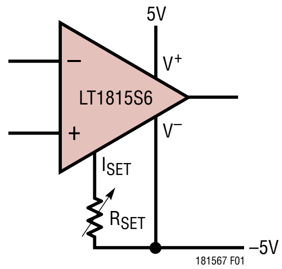


Figure 1. Programming Resistor Between I_{SET} and V^-

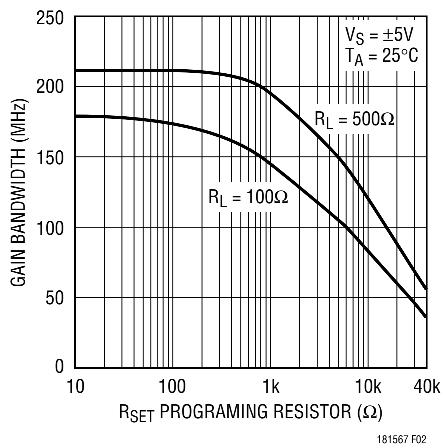


Figure 2. Gain Bandwidth Product vs R_{SET} Programming Resistor

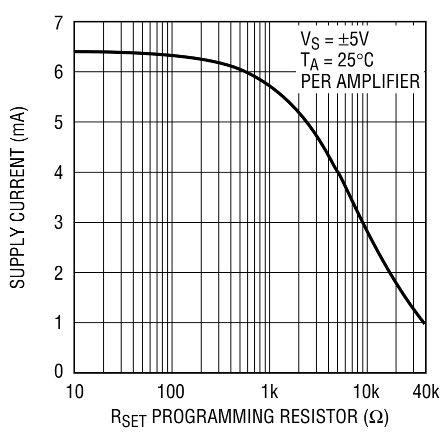


Figure 3. Supply Current vs R_{SET} Programming Resistor

Power Dissipation

The LT1815/LT1816/LT1817 combine high speed and large output drive in small packages. It is possible to exceed the maximum junction temperature specification (150°C) under certain conditions. Maximum junction temperature (T_J) is calculated from the ambient temperature (T_A), power dissipation per amplifier (P_D) and number of amplifiers (n) as follows:

$$T_J = T_A + (n \bullet P_D \bullet \theta_{JA})$$

Power dissipation is composed of two parts. The first is due to the quiescent supply current and the second is due to on-chip dissipation caused by the load current. The worst-case load induced power occurs when the output voltage is at 1/2 of either supply voltage (or the maximum swing if less than 1/2 the supply voltage). Therefore P_{DMAX} is:

$$P_{DMAX} = (V^+ - V^-) \bullet (I_{SMAX}) + (V^+/2)^2/R_L \text{ or}$$

$$P_{DMAX} = (V^+ - V^-) \bullet (I_{SMAX}) + (V^+ - V_{OMAX}) \bullet (V_{OMAX}/R_L)$$

Example: LT1816IS8 at 85°C, $V_S = \pm 5V$, $R_L = 100\Omega$

$$P_{DMAX} = (10V) \bullet (11.5mA) + (2.5V)^2/100\Omega = 178mW$$

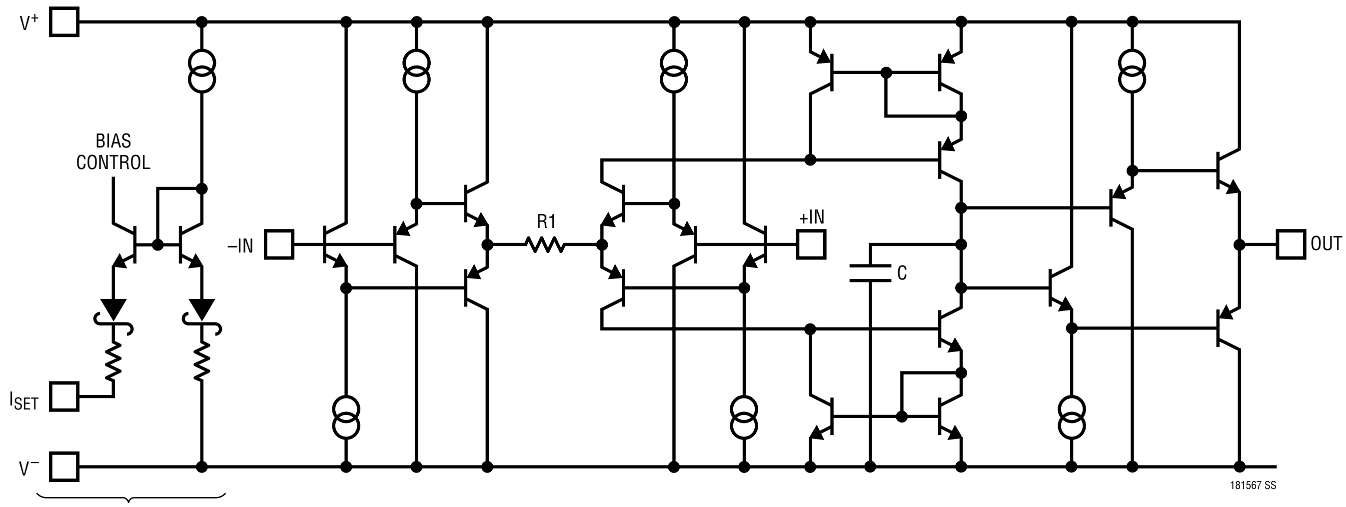
$$T_{JMAX} = 85°C + (2 \bullet 178mW) \bullet (150°C/W) = 138°C$$

Circuit Operation

The LT1815/LT1816/LT1817 circuit topology is a true voltage feedback amplifier that has the slewing behavior of a current feedback amplifier. The operation of the circuit can be understood by referring to the Simplified Schematic. Complementary NPN and PNP emitter followers buffer the inputs and drive an internal resistor. The input voltage appears across the resistor, generating current that is mirrored into the high impedance node.

Complementary followers form an output stage that buffers the gain node from the load. The input resistor, input stage transconductance and the capacitor on the high impedance node determine the bandwidth. The slew rate is determined by the current available to charge the gain node capacitance. This current is the differential input voltage divided by R1, so the slew rate is proportional to the input step. Highest slew rates are therefore seen in the lowest gain configurations.

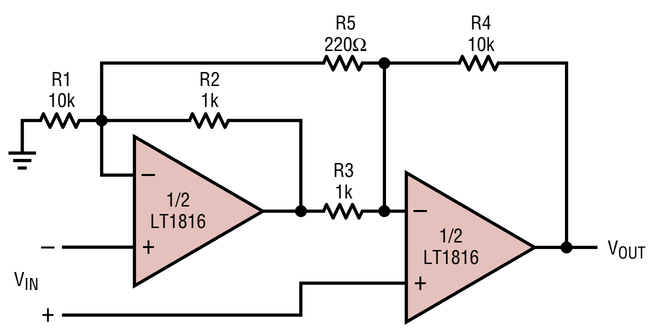
SIMPLIFIED SCHEMATIC (one amplifier)



LT1815S6/LT1816AMS ONLY

TYPICAL APPLICATIONS

Two Op Amp Instrumentation Amplifier



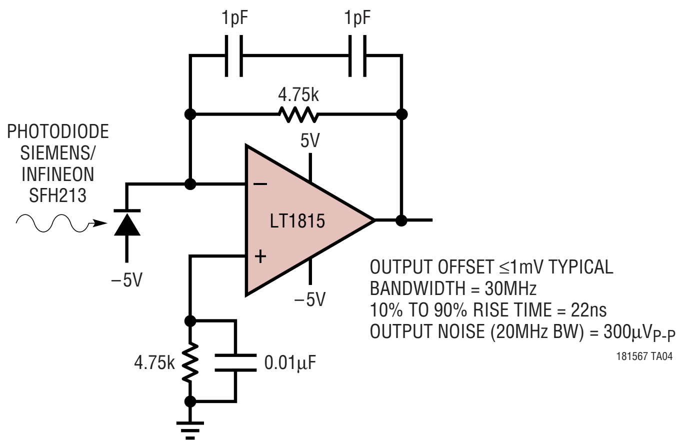
$$\text{GAIN} = \left[\frac{R4}{R3}\right]\left[1 + \left(\frac{1}{2}\right)\left(\frac{R2}{R1} + \frac{R3}{R4}\right) + \frac{(R2 + R3)}{R5}\right] = 102$$

TRIM R5 FOR GAIN
TRIM R1 FOR COMMON MODE REJECTION
BW = 2MHz

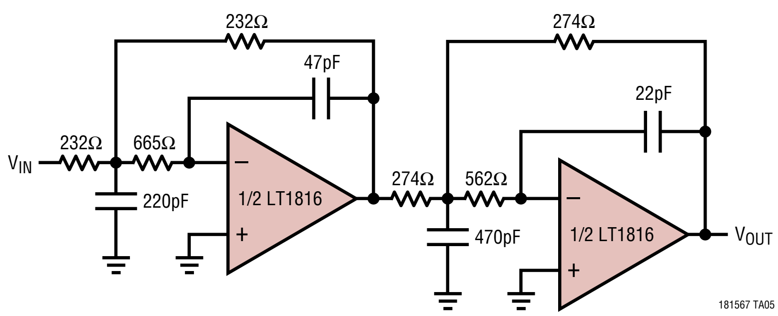
181567 TA03

TYPICAL APPLICATIONS

Photodiode Transimpedance Amplifier

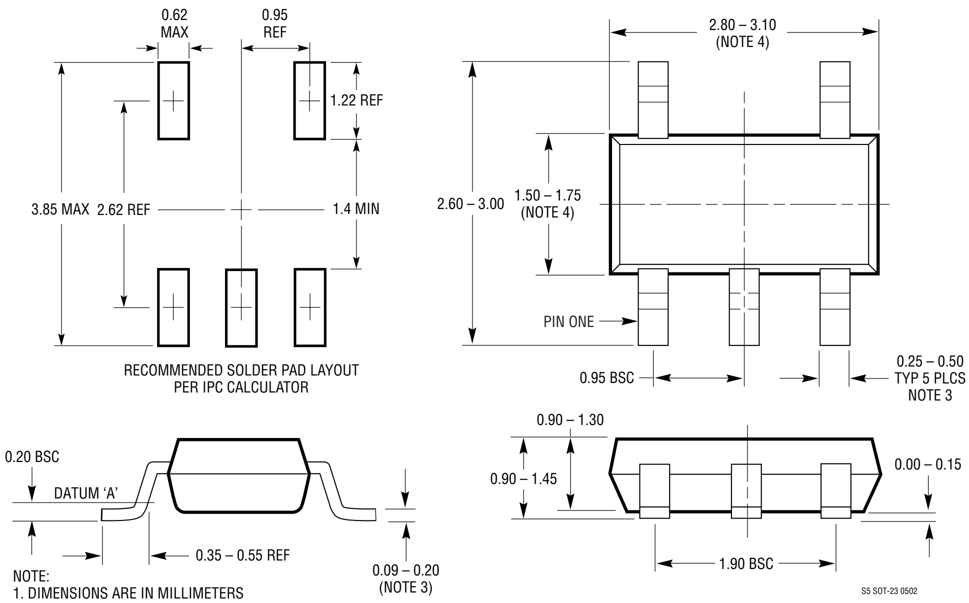


4MHz, 4th Order Butterworth Filter



PACKAGE DESCRIPTION

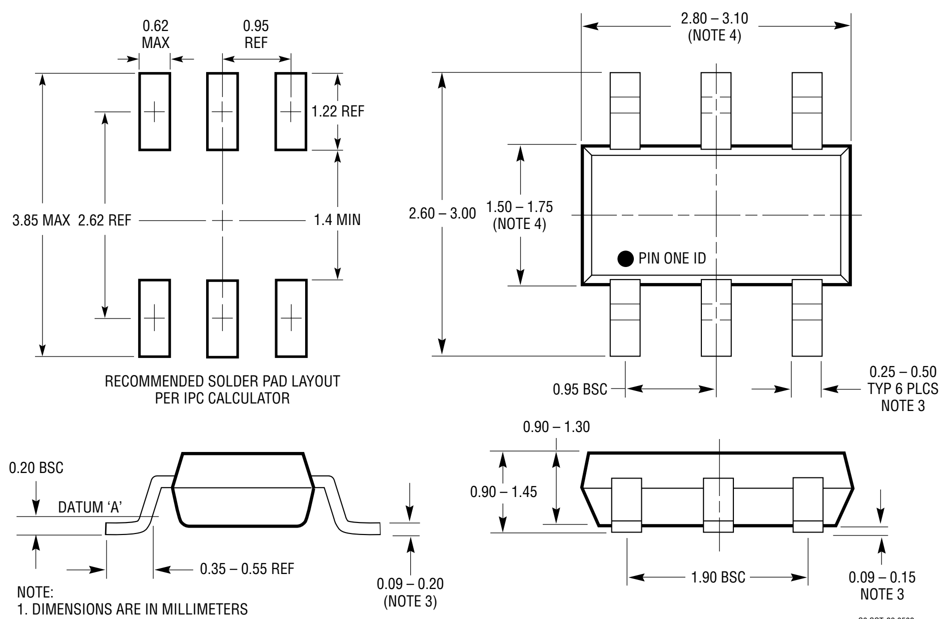
S5 Package
5-Lead Plastic SOT-23
(Reference LTC DWG # 05-08-1633)
(Reference LTC DWG # 05-08-1635)



NOTE:
1. DIMENSIONS ARE IN MILLIMETERS
2. DRAWING NOT TO SCALE
3. DIMENSIONS ARE INCLUSIVE OF PLATING
4. DIMENSIONS ARE EXCLUSIVE OF MOLD FLASH AND METAL BURR
5. MOLD FLASH SHALL NOT EXCEED 0.254mm
6. PACKAGE EIAJ REFERENCE IS SC-74A (EIAJ)

ATTENTION: ORIGINAL SOT23-5L PACKAGE.
MOST SOT23-5L PRODUCTS CONVERTED TO THIN SOT23 PACKAGE, DRAWING # 05-08-1635 AFTER APPROXIMATELY APRIL 2001 SHIP DATE

S6 Package
6-Lead Plastic SOT-23
(Reference LTC DWG # 05-08-1634)
(Reference LTC DWG # 05-08-1636)

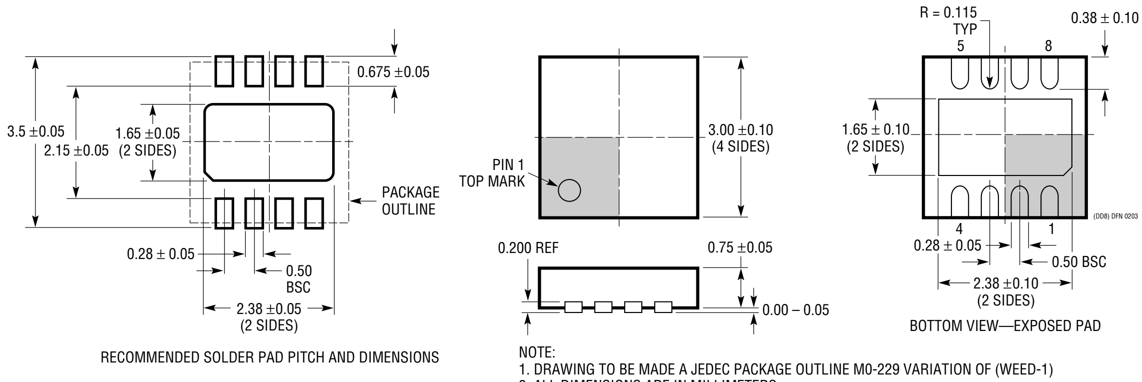


NOTE:
1. DIMENSIONS ARE IN MILLIMETERS
2. DRAWING NOT TO SCALE
3. DIMENSIONS ARE INCLUSIVE OF PLATING
4. DIMENSIONS ARE EXCLUSIVE OF MOLD FLASH AND METAL BURR
5. MOLD FLASH SHALL NOT EXCEED 0.254mm
6. PACKAGE EIAJ REFERENCE IS SC-74A (EIAJ)

ATTENTION: ORIGINAL SOT23-6L PACKAGE.
MOST SOT23-6L PRODUCTS CONVERTED TO THIN SOT23 PACKAGE, DRAWING # 05-08-1636 AFTER APPROXIMATELY APRIL 2001 SHIP DATE

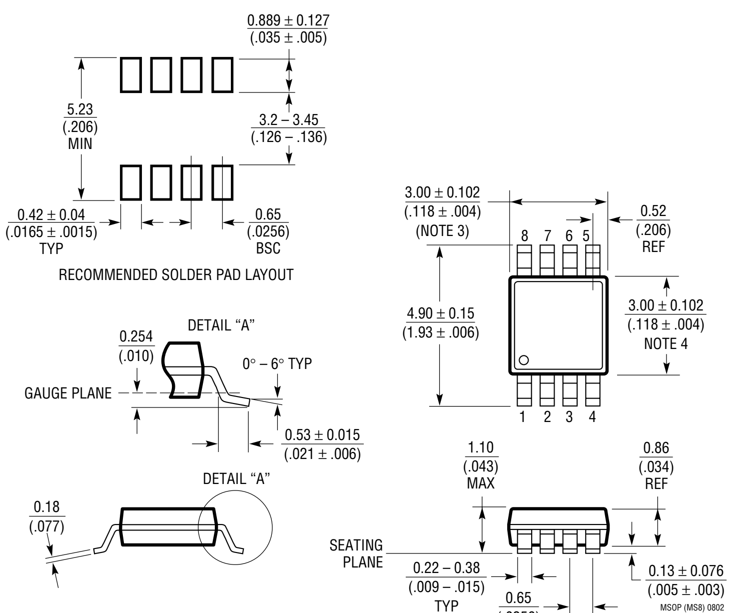
PACKAGE DESCRIPTION

DD Package
8-Lead Plastic DFN (3mm × 3mm)
(Reference LTC DWG # 05-08-1698)



NOTE:
1. DRAWING TO BE MADE A JEDEC PACKAGE OUTLINE M0-229 VARIATION OF (WEED-1)
2. ALL DIMENSIONS ARE IN MILLIMETERS
3. DIMENSIONS OF EXPOSED PAD ON BOTTOM OF PACKAGE DO NOT INCLUDE MOLD FLASH. MOLD FLASH, IF PRESENT, SHALL NOT EXCEED 0.15mm ON ANY SIDE
4. EXPOSED PAD SHALL BE SOLDER PLATED

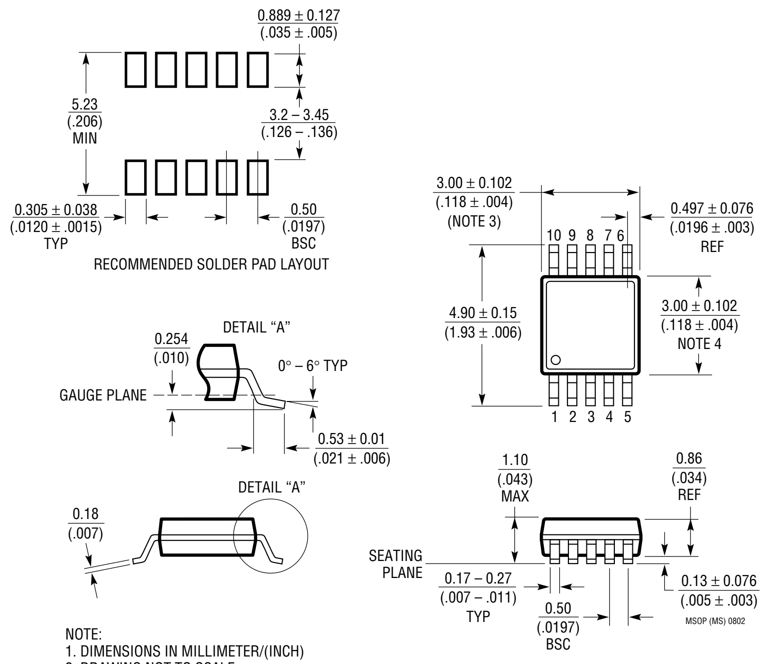
MS8 Package
8-Lead Plastic MSOP
(Reference LTC DWG # 05-08-1660)



NOTE:
1. DIMENSIONS IN MILLIMETER/(INCH)
2. DRAWING NOT TO SCALE
3. DIMENSION DOES NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS. MOLD FLASH, PROTRUSIONS OR GATE BURRS SHALL NOT EXCEED 0.152mm (.006") PER SIDE
4. DIMENSION DOES NOT INCLUDE INTERLEAD FLASH OR PROTRUSIONS. INTERLEAD FLASH OR PROTRUSIONS SHALL NOT EXCEED 0.152mm (.006") PER SIDE
5. LEAD COPLANARITY (BOTTOM OF LEADS AFTER FORMING) SHALL BE 0.102mm (.004") MAX

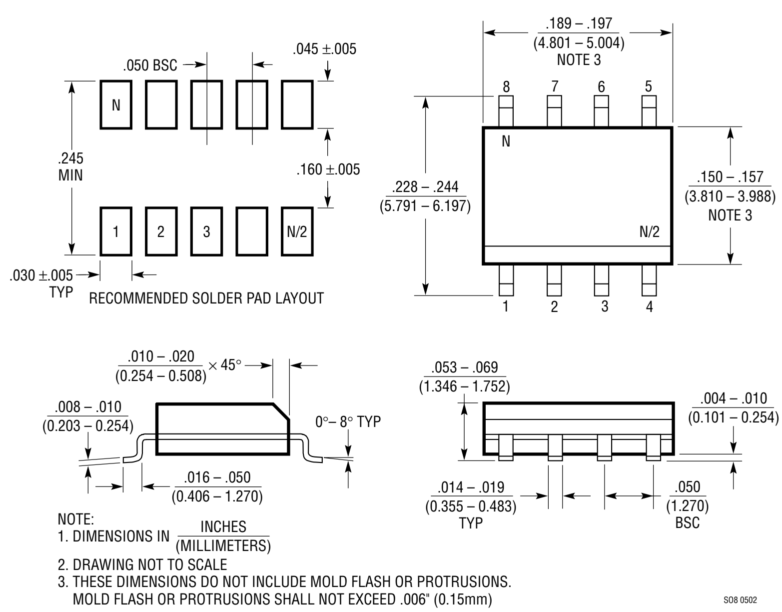
PACKAGE DESCRIPTION

MS10 Package
10-Lead Plastic MSOP
(Reference LTC DWG # 05-08-1661)



NOTE:
1. DIMENSIONS IN MILLIMETER/(INCH)
2. DRAWING NOT TO SCALE
3. DIMENSION DOES NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS.
MOLD FLASH, PROTRUSIONS OR GATE BURRS SHALL NOT EXCEED 0.152mm (.006") PER SIDE
4. DIMENSION DOES NOT INCLUDE INTERLEAD FLASH OR PROTRUSIONS.
INTERLEAD FLASH OR PROTRUSIONS SHALL NOT EXCEED 0.152mm (.006") PER SIDE
5. LEAD COPLANARITY (BOTTOM OF LEADS AFTER FORMING) SHALL BE 0.102mm (.004") MAX

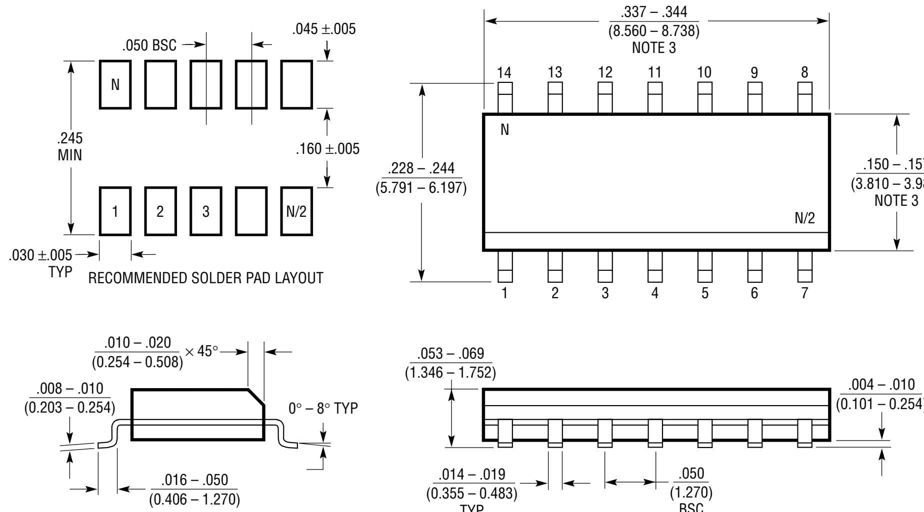
S8 Package
8-Lead Plastic Small Outline (Narrow .150 Inch)
(Reference LTC DWG # 05-08-1610)



NOTE:
1. DIMENSIONS IN $\frac{\text{INCHES}}{\text{(MILLIMETERS)}}$
2. DRAWING NOT TO SCALE
3. THESE DIMENSIONS DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS.
MOLD FLASH OR PROTRUSIONS SHALL NOT EXCEED .006" (0.15mm)

PACKAGE DESCRIPTION

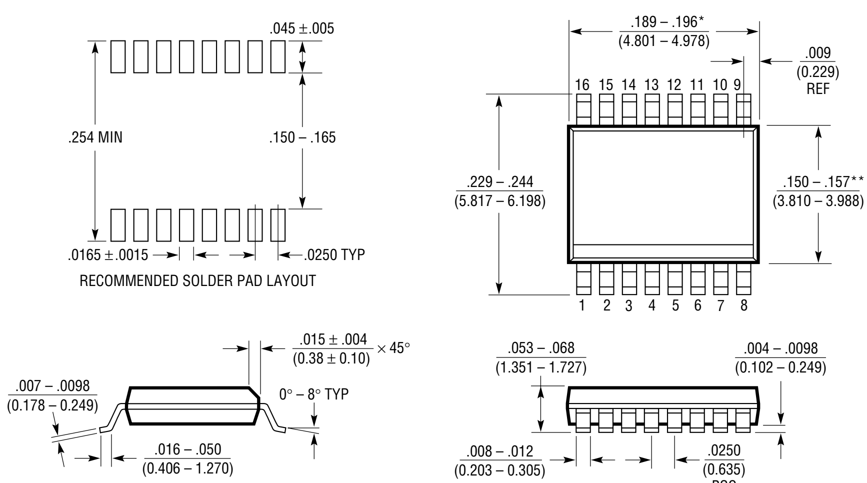
S Package
14-Lead Plastic Small Outline (Narrow .150 Inch)
(Reference LTC DWG # 05-08-1610)



S14 0502

NOTE:
1. DIMENSIONS IN $\frac{\text{INCHES}}{\text{(MILLIMETERS)}}$
2. DRAWING NOT TO SCALE
3. THESE DIMENSIONS DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS.
MOLD FLASH OR PROTRUSIONS SHALL NOT EXCEED .006" (0.15mm)

GN Package
16-Lead Plastic SSOP (Narrow .150 Inch)
(Reference LTC DWG # 05-08-1641)



NOTE:
1. CONTROLLING DIMENSION: INCHES
2. DIMENSIONS ARE IN $\frac{\text{INCHES}}{\text{(MILLIMETERS)}}$
3. DRAWING NOT TO SCALE

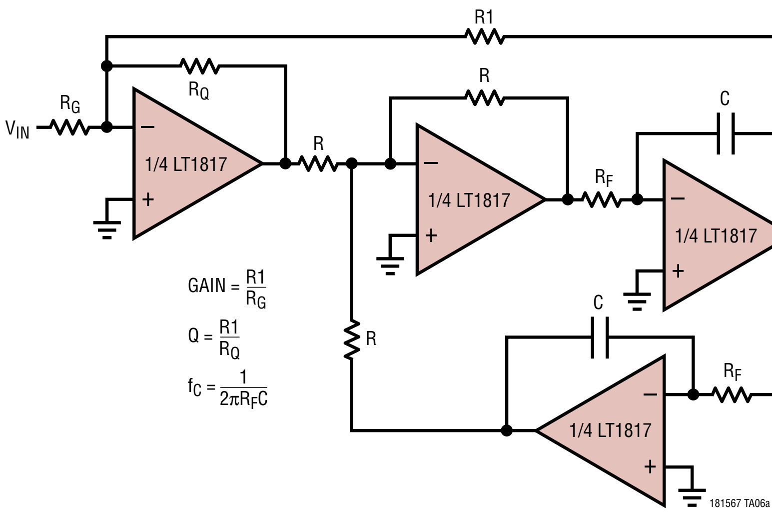
GN16 (SSOP) 0502

*DIMENSION DOES NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED 0.006" (0.152mm) PER SIDE
**DIMENSION DOES NOT INCLUDE INTERLEAD FLASH. INTERLEAD FLASH SHALL NOT EXCEED 0.010" (0.254mm) PER SIDE

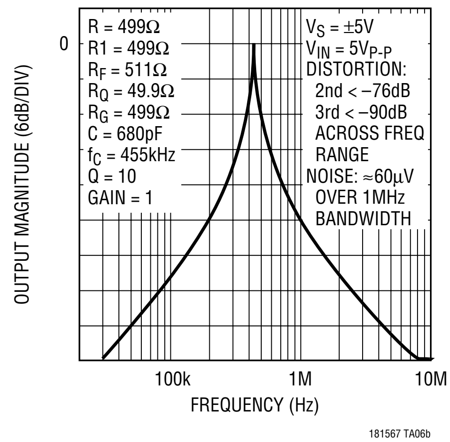
181567fa

TYPICAL APPLICATIONS

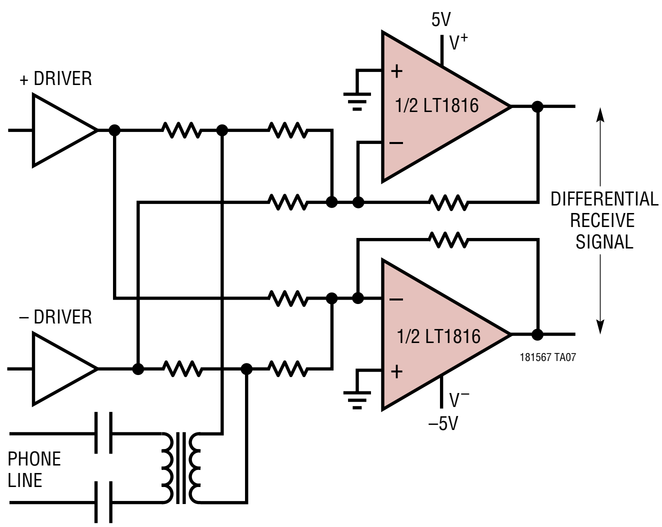
Bandpass Filter with Independently Settable Gain, Q and f_C



455kHz Filter Frequency Response



Differential DSL Receiver



RELATED PARTS

PART NUMBER	DESCRIPTION	COMMENTS
LT1363/LT1364/LT1365	Single/Dual/Quad 70MHz, 1V/ns, C-Load™ Op Amp	Wide Supply Range: ±2.5V to ±15V
LT1395/LT1396/LT1397	Single/Dual/Quad 400MHz Current Feedback Amplifier	4.6mA Supply Current, 800V/µs, 80mA Output Current
LT1806/LT1807	Single/Dual 325MHz, 140V/µs Rail-to-Rail I/O Op Amp	Low Noise: 3.5nV/√Hz
LT1809/LT1810	Single/Dual 180MHz, 350V/µs Rail-to-Rail I/O Op Amp	Low Distortion: 90dBc at 5MHz
LT1812/LT1813/LT1814	Single/Dual/Quad 3mA, 100MHz, 750V/µs Op Amp	Low Power: 3.6mA Max at ±5V

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